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BUILDING SITUATIONAL AWARENESS IN FORCE XXI

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BY

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ABSTRACT

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       The end of the Cold War, combined with the advent of a technological revolution, is presenting the Army with an unprecedented opportunity and need to redefine military operations. Force XXI is the Army's program to lead us into the 21st Century. Force XXI is about integration--taking existing technology and systems, leveraging new technology, and digitizing the battlefield to create an interactive, interoperable, lethal force that can dominate battlespace and execute a quicker, more decisive victory. The emphasis of this study is on the effectiveness of systems, technology and information to provide situational awareness for decision-making. This paper will examine, from an intelligence perspective, whether planned processes for information collection, processing, dissemination, and display are adequate to meet the Force XXI goal of situational awareness for decision-making. The conclusion reached is that we are seeing overwhelming evidence that the degree of uncertainty will be reduced significantly; what we know about the battlefield, its geometry, and the disposition, capability and intentions of friendly and enemy units will be exponentially greater than it has ever been, and that it will improve even more with digitization. Commanders will be more situationally aware, but we will not achieve a goal of 100 percent situational awareness.

Introduction

The end of the Cold War, combined with the advent of the technological revolution, is presenting the Army and the other services with an unprecedented opportunity and need to redefine military operations for the 21st Century. The threat that existed for the last fifty years has diminished greatly, yet our environment is one full of challenge and ambiguity. The new multipolar geopolitical world, which presents new, multiple and unpredictable threats, calls for an American force that is flexible and adaptable--ready to address all contingencies. The pace of operations is busier than ever, yet the services are facing downsizing and dramatic budget cuts. Each service is addressing its warfighting business, looking for ways to operate with a smaller, yet more lethal force. Accessing information and leveraging technology are central to a new way of warfighting. Information and technology, when combined with changes in doctrine and organization, should be able to create conditions for decisive victory. Admiral (Ret) David B. Jeremiah says that "global dominance will be achieved by those that most clearly understand the role of information and the power of knowledge that flows from it."[1] In his Annual Report to the President and the Congress, Secretary of Defense William Perry cites the Command, Control, Communications, Computers, and Intelligence (C4I) goal as the establishment and maintenance of information superiority in support of the National Security Strategy.[2] Each service has a program to catapult it into the next century--the Navy program is "Forward . . . From the Sea, "the Air Force has "Global Reach, Global Power," the Marine Corps has "Operational Maneuver . . . From the Sea," and the Army, "Force XXI."

General (Ret) Sullivan describes Force XXI as a campaign plan--an evolutionary "journey for the Army as an institution."[3] Force XXI is about integration--taking existing technology and

systems, leveraging new technology, and digitizing the whole works to create an interactive, interoperable force on the battlefield. There are three axes to the Force XXI Campaign Plan--the redesign of Army operational forces, the reinvention of the Institutional Army, and the development and acquisition of information-age technologies.[4]

This research paper will touch on all three axes, however, its focus will be on the third-- information-age technologies. The emphasis will be on Command, Control, Communications, and Intelligence (C4I) programs and their battlefield architecture, and the effectiveness of systems, technology and information to enhance decision making. Decision making is facilitated by the achievement of situational awareness. This paper will examine, from an intelligence perspective, whether planned processes for information collection, processing, dissemination, and display are adequate to meet the Force XXI goal of situational awareness for decision making.

Background

The U.S. Army is arguably the most powerful Army in the world. However, the changing threat, increasingly constrained resources and the downsizing of our forces calls for us to fight smarter and better, in all types of contingencies, with fewer forces. General Sullivan's strategic goal was to create "a force for the 21st Century that is more lethal, survivable, capable of sustained high tempo operations, deployable, versatile and sustainable, and with increased joint and combined activity.[5] General Reimer has continued the effort and validated Force XXI as a means for "managing institutional change and exploiting the revolution in military affairs."[6]

Force XXI is a powerful concept, but there is no roadmap for reaching its end state. Part of the reason is that technology is driving the train. Many of our leaders and organizations don't know what technology exists, what it can do for them, or how to employ it. We do know that leveraging existing and new technology should allow us to observe, collect, process, disseminate and use more information. Leaders should be able to make quicker decisions because improved situational awareness and a common picture of the battlefield should exist at all echelons.

Information and situational awareness are two key concepts. Information is used in the context of "situational knowledge that is relevant to a particular decision or group of related decisions needed to support a plan or to execute operations.[7] Situational awareness is defined by TRADOC Pamphlet 525-5 as the "ability to have accurate and real-time information of friendly, enemy, neutral, and noncombatant locations; a common, relevant picture of the battlefield scaled to specific level of interest and special needs.[8]

Force XXI builds on lessons learned from recent contingencies. A key Desert Storm finding was that situational awareness was a prime ingredient for command and control agility,

and for commanders to make the right decisions.[9]   It was clear that the Army required

responsive intelligence, communications and automation support.

Two lessons learned were that critical assets must deploy early[10] and keep up with

maneuver.[11] Unfortunately, key intelligence and communications assets were often sequenced

into theater later than the combat elements which relied upon them. Once there, intelligence and

communications were unable to keep up with the pace of the operation. Satellite

communications quickly showed their value and their employment increased dramatically;

however, the Army communications system as a whole could not support intelligence needs. In

the intelligence community, fielding a special communications system (Trojan Spirit) provided a

lifeline to the commands.

Another lesson was the need for a viable intelligence dissemination architecture.

Dissemination was the Achilles heel of intelligence, especially imagery dissemination.[12] There

were too many requests for information and analysts tried to provide too much data. Units

exercised little discipline, with message sizes experiencing a fifty percent growth and the fragile

communications network experiencing saturation and widespread precedence abuse.[13]

Hierarchical dissemination practices and information overclassification also caused delays. The

result was that commanders often felt overwhelmed by intelligence and information commanders

received was often too late and/or of little value.[14] The lack of responsiveness also can be

attributed to systems which had different protocols, standards, or operating procedures, coming

as they were from multiple sensors, processors, and layers of command.

Desert Storm pointed to the need for an imagery architecture that could provide respon-

sive, wide area, high resolution, imagery on areas and items of interest.[15] Commanders wanted

4

large volumes of high resolution imagery. Each corps requested approximately 600 frames and each division, an additional 30 to 50 frames per day.[16] Secondary imagery was in its infancy and not satisfactory. Hard copy photos were hard to process and had to be flown to each site.

That is not to say that there weren't successes or positive lessons. Never before had information played as significant a role in synchronizing allied and U.S. forces to achieve such a decisive and rapid victory. MG (Ret) Stewart, then ARCENT G2, points to the significant contributions made by Joint Surveillance Target Attack Radar System (JSTARS) and the Unmanned Aerial Vehicle (UAV) to the success of the battle.[17]

However, as a whole, the flow of data and imagery in Desert Storm was neither smooth nor efficient and satisfactory situational awareness was not achieved. A Rand study found that there was no common picture of the battlefield, either vertically or horizontally.[18]

Subsequent contingencies have reconfirmed Desert Storm lessons. Dissemination and lack of access to information plagued forces in Haiti[19] and Somalia. This was due to reliance on a stove-piped, hierarchical architecture, combined with limited communications channels and bandwidth, information overclassification, and incompatible operating systems.

Taking these lessons seriously, the Military Intelligence (MI) community is on the leading edge of the technology revolution and has built a program for Force XXI. The MI Relook Study (lessons from Desert Storm) and the Army Intelligence Master Plan (continuously updated) have contributed to the rewrite of doctrine and definition of a family of systems that span the entire battlefield and incorporate all echelons of command. The new MI doctrine for Force XXI is based on five principles: the commander drives intelligence, tactical tailoring, split-based operations, intelligence synchronization, and broadcast dissemination. The doctrine

(promulgated in the 34-Series of Field Manuals) takes the force from the predeployment stage through conflict resolution, and has been tested in contingencies and found viable. Systems supporting the doctrine are being fielded, and Tactics, Techniques, and Procedures (TTP) manuals are being written. In contrast to Desert Storm, many senior Army leaders now cite intelligence as leading the way in terms of leveraging technology, digitization, and support to the warfighter. In the following pages, an examination is made of the ability of these intelligence processes, combined with other Battlefield Functional Areas (BFA) processes, to support situational awareness and decision making.

C4 Subarchitectures as a Component of Battlefield Architecture

The battlefield architecture consists of all BFA's, their systems and their processes. C4 subarchitectures are a subset of this overall architecture and have three basic components. The first comprises information sources, such as sensors that collect data, and operational units that provide input. The next component includes the collection management, production, and dissemination facilities. In the intelligence area, this translates to the Analysis and Control Element (ACE) and Joint Intelligence Center (JIC) at the tactical and operational levels, respectively. Commanders, decision makers, and other users are the last component.[20]

While it might seem to make sense to take these subarchitectures in order, the fact is that we must both start and finish with the commander. Never before has this been as true and as necessary as on the digitized battlefield.

The process begins with Commander's intent, his perception of the battlefield and his Commander's Critical Information Requirements (CCIR). The more specific and less ambiguous a commander can be about his intent, the better. There is an equal need for subordinates to

correctly interpret the commander's intent. Only when these commander/subordinate dynamics are met, will the commander have some assurance that he will get what he wants.

Subordinates also must understand the commander's perception of the battlefield. The commander's perception consists of a "dynamic image of the battlefield that will lead him to understand what action needs to be taken. This image is the commander's mental model of the entire battlefield and its surroundings, to include political, military and psychological considerations."[21] The image is not a snapshot, but is based on a historical perspective that leads to the current and future friendly and enemy situation. The image also includes the commander's intuition and sensing of the battlefield, developed from years of experience.

The last piece is the formulation of clear, concise CCIR. The Priority Intelligence Requirements (PIR), a subset of the CCIR, direct the intelligence collection effort. Focused PIR enhance the probability that the commander will get required information within his decision cycle. The wargaming process which takes place during mission analysis is absolutely vital to deriving focused PIR. When taken as a whole, intent, articulation of perception, and CCIR help ensure that the commander is not overwhelmed with either too much information or with information which he really does not need. The commander really does drive intelligence.

While it is best if a commander can communicate his requirements, intent and perception personally, multimedia tools such as video teleconferencing (VTC) with a shared whiteboard and collaborative planning tools permit commanders and staffs to reach a common understanding over great distance. A shared white board application permits the same image to be viewed and annotated by multiple participants. Collaborative tools allow the user to enter text and graphics onto a white board using a mouse and key pad. This technology is at hand today. Armed with

and understanding the commander's needs, the staff officer now has a framework within which to synchronize operations. The goal: to permit decision making through situational awareness and visualization.

Collection

To achieve situational awareness, we must know where the enemy is and is not. The fielding of the intelligence family of systems is the lynchpin in meeting this objective. Collection systems are mostly in the development or prototype stage and include such systems as JSTARS, UAV, Ground Based Common Sensor, Advanced Quickfix, Guardrail Common Sensor, and the Enhanced Trackwolf, and the Airborne Reconnaissance Low. When employed as a seamless collection entity, these systems will comb the battlefield for information as never before. However, one should not be fooled into believing that these systems alone will be sufficient. To meet Force XXI goals, all combat, combat support, and combat service support systems and units must be digitally integrated. This means intelligence and non-intelligence assets must be designed (or redesigned) to be interoperable. There are many platforms on the battlefield whose primary mission is something besides intelligence (eg. the Apache Longbow). But, each of these platforms also is ideally suited to provide information. The problem is this secondary role is either only being recognized as an afterthought, or not at all. These information resources must be identified and made part of the information web, preferably while still in the acquisition stage.

Additional technology should be employed in collection platforms. On-board processing should be increased to the maximum extent feasible. Also, collection systems should be upgraded with a capability to detect message format errors before data is sent to processing centers. Compatible data links to central processing systems should be used to avoid complexity.

8

There are other technologies just over the horizon in infrared signature development, acoustic sensor arrays, multi-domain smart sensors, robotics, voice identification, etc. that also should be integrated as their maturity and resourcing permits.

Non-traditional information sources, along with intelligence platforms, must be part of collection plans in order to maximize our effort at finding the enemy. The tools for collection and resource management are not yet at hand. The All Source Analysis System (ASAS) and various Tactical Exploitation of National Capabilities (TENCAP) systems contain different collection management software. But there is no single seamless collection management program that takes us from the tactical through the national level. What is required is an agreement to integrate the Joint Collection Management Tools (JCMT) software or some like functionality in all systems. This will permit multi-echelon tasking and requirements tracking to occur for the first time. A required companion piece is the ability to task, track, and manage collection assets. The Intelligence School is building this software into an ASAS Reconfigurable Workstation (RWS) as a part of the Task Force (TF) XXI experiment.

While better than ever before, there are limits to collecting everything about the enemy. There are a finite number of collection systems, and the ability to cover the battlefield is highly Mission, Enemy, Terrain, Troops-Time Available (METT-T) dependent. Therefore, good Intelligence Preparation of the Battlefield, focused PIR, and Reconnaissance and Surveillance Plans are more important than ever. This limitation underscores the requirement for an automated, dynamic intelligence synchronization matrix. This matrix must also track with the mission analysis wargaming results. The Intelligence School and the XVIII Airborne Corps are working to establish a viable automated synchronization matrix..

Processing

Major processing centers are found at division level and above. ASAS is the backbone

division and corps level processing system, having been used successfully in both exercise and

real-world operations. ASAS' ability to correlate large amounts of data from multiple sensors to

display a coherent picture of the battlefield places it squarely in the Force XXI arena. ASAS was

cited by Battle Command Training Program (BCTP) senior observer controllers as having been

key to the success of division and corps level campaigns during the Unified Endeavor joint

exercise in April 1995.[22] It was evident that the picture available to the corps and division, which

had ASAS, versus the Joint Task Force Headquarters, which did not have ASAS, was more

accurate and timely, and facilitated decision-making. Part of the first equipment in country,

ASAS was also used with success in Haiti and is now fully employed in Bosnia. At the theater

level, ASAS-Extended provides theater level commands with a new capability to process all

source intelligence and to be interoperable with tactical ACE's.

At all levels, the Joint Deployable Intelligence Support System (JDISS) provides the

linkage into the unified and national level commands. In the near term, JDISS residency on

ASAS will eliminate the requirement for a separate terminal.

The concept of split-based operations permits phasing of intelligence capabilities into

theater, as well as continuous on-the-move operations in theater. A small cell deploys early with

or even ahead of the first combat units to begin processing information and sending data back to

a sanctuary or home station. This Deployable Intelligence Support Element (DISE) is tailored to

the mission, but usually consists of a Trojan Spirit, an ASAS RWS, a work station with JDISS

software, and often a TENCAP system like the Mobile Integrated Tactical Terminal (MITT) to provide downlinked near-real time data and imagery. This capability resolves problems faced in Desert Storm and it has been validated in Haiti, Bosnia, and in numerous exercises. It is part of the tactical tailoring occurring in both collection and processing.

Until now most sensor information flowed directly to major processing centers only at division and above. The MI community will field its Common Ground Station (CGS) in 1997. Systems will be fielded at the brigade level, providing a first-ever capability for the brigade to independently receive sensor data, imagery and video, and develop a time sensitive electronic picture of the battlefield (especially when combined with an ASAS RWS). The brigade intelligence challenge will be one of determining how information is merged, the level of analysis done at the CGS, which information needs to go directly to decision makers or shooters, and how to get all of it into an ASAS RWS for analysis.

Shortfalls remain in maximizing our ability to task and process valuable battlefield information, especially Counterintelligence (CI) and Human Intelligence (HUMINT). Not using these assets extensively in exercises such as a BCTP Warfighter or at the National Training Center may have contributed to a lack of understanding, until recently, on how to task them in real world contingencies. Rotations at the Joint Readiness Training Center (JRTC), with its low level intensity focus, and recent real-world activities in peace operations, which are CI/HUMINT heavy, have shown the value of these disciplines. A Rand study found that CI and HUMINT are the "highest value systems for noncombat operations for long-term situations characterized by infrequent operations by small units or groups.[23] Secretary Perry cited the demands on CI as

11

growing more complex throughout the spectrum of conflict and called for a Department of

Defense data base and automated information network.[24]

In low intensity conflicts/peace operations, important information which establishes a

pattern, trend, or provides other information (such as morale or intention) is contained in text. In

Haiti, incident tracking became critical and non-traditional information concerning civil

disturbances and criminal activity was important to follow.[25] The Theater Rapid Response

Intelligence Package (TRRIP) provides CI/HUMINT operators and analysts a single source pre-

processing tool. TRRIP has been used successfully in Haiti by the 519th MI Bn and by the 66th

MI Group in Bosnia. CI/HUMINT information also must reach the all-source data base.

Because ASAS only accepts formatted reports, important free text information cannot be merged

seamlessly into the correlated data base. A way of doing this would be to link a text field to the

data in the correlated data base, so that when an operator clicks on a symbol, the amplifying

textual information is retrieved and displayed. Such requirements exist for ASAS and hopefully

will be fielded during the next major software upgrade.[26] This tool also would be of use for

enhancing commanders' situational awareness. The problems of integrating Special Operations,

Long Range Surveillance and Open Source Intelligence (OSINT) reporting are similar to those in

CI/HUMINT.

The information superhighway and automation in general have created an explosion of

OSINT. There are two challenges in using this information. The first is the need to retrieve text

from large volumes of data, thereby allowing the analyst to concentrate on myriad other tasks.

For example, 82d Airborne Division intelligence analysts in Haiti found a wealth of information

on Internet, from names of local officials to locations of warehouses. The second challenge is to

find the pearls in this huge sea of information.[27] The National Ground Intelligence Center has developed a software package called Pathfinder. Pathfinder can sort, compare, retrieve and visualize thousands of documents at a time. The software loads the electronic media into a data base, provides analyst tools, and through link analysis, permits users to draw conclusions. Analysts compared merged 1990 and 1994 Iraqi deployment databases and found that the two sets clustered separately. This permitted analysts to conclude that, while similarities existed, Hussein's intentions were much more limited in October 1994.[28] Pathfinder, incorporated into existing systems, would significantly contribute to overall situational awareness by processing and analyzing vast amounts of information heretofore done manually. A collateral use for a Pathfinder-like capability use is in an information-protect mode to collect, establish audit trails, sniffer data, etc. to understand how secure our nets are.

Document translation is another area which confounds intelligence operations. Even if linguists are available, document translation is time consuming, diverting scarce linguist resources from other equally or more important tasks. Translator software like the FALCON system being tested at Ft. Bragg would permit a quick document scan. If of value and linguists are not available on site, the document could then be electronically scanned, digitally transmitted to a document exploitation center, then returned for user incorporation.

There are other processing improvements to be undertaken. While Signals Intelligence (SIGINT) and Imagery Intelligence (IMINT) reporting more easily conforms to standard message format, upgrades in on-board processing would significantly ease problems encountered in processing data at either interim or major processing centers. Other promising initiatives include

building neural networks to perform parallel processing, increases in computing power to eliminate report backlogs, and using an integrated approach to sensor fusion.

Perhaps the biggest challenge ahead lies in the fusion architecture for obtaining inputs on enemy sightings by non-intelligence sources located throughout the battlespace. In addition to digitally connecting these assets across the battlefield, decisions are required on report generation, report format, where reports go, and where and how they are fused. These decisions should be made now, so that architectures can be based on requirements, not technology. Because this issue cuts across all BFA's, it will be complex to resolve, especially if reporting software is hard to use or gets in the way of the primary mission. But, it is critical to providing the commander situational awareness.

Similarly, digitization should finally allow a more realistic and speedy assessment of Battle Damage Assessment (BDA). As MG Stewart suggests, "BDA is an art, not a science, and it is an emotional issue."[29] However, through automated reporting, a BDA architecture, and a relational spreadsheet data base linked to the main data base, great strides can be made to objectively quantify this art.

Imagery technology continues to evolve. High quality, soft copy imagery can now be obtained by processing centers through TENCAP systems. At certain commands, the Mobile Imagery Exploitation Center and other Receive Locations (RL) will permit first phase exploitation of imagery in direct response to the commanders' needs. For other processing centers, such as JICs, divisional ACE's, and brigades with no organic RL, imagery can now be digitally transmitted using compression techniques. Most of these centers have few imagery analysts. Therefore, imagery must be annotated before being disseminated to these centers. In

the future, as automated target recognition technology matures, basic imagery can be pushed to or pulled by these centers and analysts can rapidly present information to the commander. The combination of standardized formats, compression, and digital imaging transmission advances, along with other new technologies, will streamline the imagery architecture. As the national imagery community places its priority on and refines its support to the warfighter, the process, along with the technology, should provide the necessary imagery support.

Another form of imagery is video, provided by platforms like the UAV. Video terminals terminate in centers on the battlefield to provide real-time, excellent resolution of targets or areas of interest. In the future, video should be displayed on multi-purpose workstations.

We have addressed collection and processing, but before the correlated product is passed to the commander, there is one more important player--the analyst. The analysts plays a critical role because he takes all of this processed data and other information and creates intelligence. This is where science and art merge to become "sciart."

It is important for the analyst to understand the dynamics of data and how to leverage it for situational awareness. There is no lack of data on the digitized battlefield. The analyst creates a product for the commander based on a multi-step process. The analyst takes the enemy situation, provided by the intelligence processor, and the blue picture, provided by a command and control system. He adds the blue and red political, economic, psychological perspective. He evaluates the significance of events, and intangibles such as morale. He factors in what he knows about the enemy and what he does not know and assesses possible, probable, or known enemy intentions. Thus, a product is formed to create the situational awareness for the commander. Analysis is a very ambiguous process. Knowledge based tools are required to assist

both the analyst and decision maker. With further maturity, artificial intelligence is forecast to enhance the probability of an accurate and more timely assessment.

Independent analysis can occur now at all intelligence centers on the battlefield, in sanctuaries and in the national capital region. Each center reaches independent conclusions and develops its own interpretation or picture of the battlefield. It might seem that we have created chaos--multiple, redundant, yet different pictures of the battlefield. The solution is for pictures and assessments to be shared and agreed upon to create a common picture of the battlefield. In a division, final authority rests with the G2.

Dissemination

The next process is dissemination. The future lies in the push-pull architecture developed by the intelligence community. In the past, intelligence has been a hierarchical discipline, with information being pushed up or down, from echelon to echelon. The new architecture permits skip echelon and networked dissemination.

The "push" of information is best served when it responds to certain criteria. The criteria (continuously reevaluated) might be based on a time interval, on specific information needs, or on attainment of a new level of battlefield awareness. Entire data bases can be pushed, if required, although this is not a quick or easy chore, primarily due to the lack of maturity in software, declassification issues, a continuing lack of systems interoperability, and communications challenges. Centers can also push updates or single pieces of information, as required, given the ability of the terminating machine to read the data. More often, it is an intelligence estimate (graphical and textual) that is pushed. This remains a time consuming process, because there is too much human intervention and manipulation required to create

16

updates as frequently as many commanders or centers request or expect. The bottom line is, while we are able to create and disseminate graphic and textual updates better than ever, there is still a long way to go before this process achieves the required maturity.

"Pull" technology is progressing extraordinarily quickly and provides great promise. The Intelligence School and the ASAS Program Office are developing software which will allow users to pull information as needed.

A very innovative dissemination initiative called Intelligence Link (Intelink) is now in use. Intelink permits users to enter its network and pull desired information. It is based on the Internet concept and uses web browser software to negotiate through data. Organizations can create home pages. Archived text, databases, and imagery are available for any user with the appropriate password. Intelink files can be converted by users to graphic files (like Microsoft Powerpoint) to support further dissemination or manipulation as desired. Additionally, at the request of a user, commands with home pages can place information or imagery on Intelink for access as the consumer is ready. In the future, Intelink may be organized by both command and by function, increasing its utility to the user. It has been used in experiments at the 4th Infantry Division (Mechanized) (4th ID), for garrison and exercise intelligence operations, and in real world contingency operations such as Haiti and Bosnia. Clearly, this type of user-friendly software would have equal applicability for C2 the other BFA's as well.

This Internet-like concept is the wave of the future. Fort Hood units also have created their own Home Pages on ASAS-RWS' to allow subordinate commands to pull intelligence. Access exists to multiple data bases, multi-media hypertext information, and graphics. The concept can be tailored to the user or the user can select and filter, then display and manipulate a

17

variety of media and information as time or need permits. Information can be stored in an interim file server until the consumer retrieves it, thereby freeing hard drive space on the producer's system.

Broadcast dissemination is also a form of "push-pull" dissemination which promises to bring great value added to the battlefield. Broadcast has long been used by TENCAP and defense warning systems. Now, broadcast technology will permit processing centers to disseminate simultaneously to multiple users on the battlefield. Users can filter the information which is of value to them, thus avoiding extraneous information or information overload. Broadcast is especially valuable for high value, fleeting targets with extremely short dwell time.

The digitized battlefield is dependent on reliable, secure communications for dissemination. To win the information war, the we must dominate the electro-magnetic spectrum. Shortcomings in communications have been documented during all contingencies, the main issues dealing with mobility, range, bandwidth, data rate, error rate, throughput, sufficiency and redundancy. The intelligence community alone has overwhelmed the capability of communicators, thereby necessitating the introduction of Trojan Spirit and MG Stewart's call in his Desert Storm after action report for a dedicated intelligence communications system.[30] Trojan Spirit, along with the Joint Worldwide Intelligence Communications System (JWICS), remains the intelligence community's most reliable means of communications.

All services are just now transitioning from an analog to a digital communications design. Force XXI initiatives in communications call for a greater reliance by all BFA's on satellite communications, fiber optics, wire, and long-range wireless systems. Initiatives incorporate Asynchronous Transfer Mode (ATM)/Synchronous Optical Network (SONET) technology,

18

cellular technology, efficient antennae, packet and multimedia compression, protocol filtering, automating routing and reconfiguration, and improved data modems. The 4th ID has used ATM to set up multi-media networks. This includes installing ATM switches in the Mobile Subscriber Network to optimize bandwidth. The Global Broadcasting System (GBS) and the Direct Broadcasting System (DBS) should make broadcast dissemination commonplace. The Tactical Internet is expected to provide a seamless communications network on the tactical battlefield. It is absolutely critical that we have these communications capabilities and that they be interoperable, from foxhole to the national command center. Things that increase complexity-- routers, bridges, packet switches, satellite circuits--must be simplified to prevent potential transmission glitches. To ensure maximum operational efficiency, an automated network planning management and troubleshooting system must be installed. Like sensors, there will never be enough bandwidth. An appetite suppressant, focused CCIR, and push-pull dissemination will help keep the networks from oversaturation. We will not meet the Force XXI goal without the communications backbone.

Commanders' Display

The final architectural subcomponent is the commander and leads to a discussion of display, situational awareness and decision making. TRADOC Pamphlet 525-5 describes the army battle command system process as the "integration of broadcast battlefield information, as well as information from other sources, including real-time friendly and enemy situations, into a digitized image that can be displayed graphically in increasingly mobile and heads-up displays."[31] Collective unit images forming the battlespace are what result in a common picture and bring the battlefield to life. Vertical and horizonal linkages are what allow the commander to visualize

19

how the battle will be executed. It is the scalable common picture, along with the knowledge of friendly and enemy locations, which creates situational awareness. As LTG Menoher, Army Deputy Chief of Staff for Intelligence (DCSINT) describes the requirement, we want to give the commander a screen "on which he can see, plan, and rehearse fights; understand the fight; articulate to subordinates how he sees the fight; and be able to develop branches and sequels to the plan if the enemy does something other than what we expect."[32] The system must be dynamic and interactive, with mapping and visualization aids for decision making.

The Maneuver Control System (MCS)-Phoenix now being prototyped by the Battle Command Battle Lab and Ft. Hood likely will serve as the primary tactical command and control system. Blue and red data are now displayed on the same screen with one point and click. A system of alarms and triggers exists to provide notification of information that meets a commander's CCIR. However, there are still problems with scalability and clutter, and the interface is not as user friendly as it needs to be[33]. The system cannot yet handle automatic, dynamic updates, even if the inputting systems were capable of generating them. Issues involving the use of common graphics also prevent seamless updating and display. There is also a need to be able to display information gaps. Phoenix and all C2 systems will need to be designed for interoperability, with minimal protocols and standardized formats for graphics, software, maps, photos, overlays, mosaics, symbols, icons and messages. Despite the long road ahead, extraordinary progress is being made.

One valuable enhancement to situational awareness is the ability to display blue and red on three dimensional terrain--especially Multi Spectral Imagery (MSI)--as a background on which enemy and friendly units can be superimposed. The DCSINT initiative to use the NASA

shuttle missions for producing Digital Terrain Elevation Data-Level 4 mapping will provide even better map backgrounds for all aspects of planning, operating, and decision-making. Just as there are unresolved fusion architecture issues for intelligence, there are similar issues associated with fusing all the commander's information requirements. Decisions on what and how much is provided to the commander (all personality dependent) must be made. Care must be given to ensure that the data integration process does not distract the commander from command and control. Multisensory information displays must be created, based on commanders' needs. Rand envisions the end state as "a series of graphic images that could be viewed individually or in combination, much as a series of acetate overlays are placed on a map, to produce a composite illustration of particular facts related to a particular area and situation"[34]. These images will help the commander visualize changes and patterns in information.

Earlier, we discussed the problem of information overload. Good, focused CCIR are the key. However, these alone can not prevent information from either overwhelming the commander or reaching him too late. Message priority software tools are required so a commander can choose to receive that information he wants first. The Naval Research Laboratory has been working on software which address this prioritization issue. Also, to help ensure that the data he needs reaches him, a systems integrating vehicle (SIV), like that recently used by 4th ID, should be part of the architecture. This SIV "sniffs" out where bottlenecks and undisciplined users are clogging up the network.

There is superb work ongoing in the field, at III Corps, XVIII Airborne Corps, and other places, in the area of multi-media presentation. Through the use of VTC, shared white boards, and other collaborative planning tools, commanders are able, as never before, to resolve planning

21

and operational issues vertically and horizontally with their commanders and staffs. MG Coffey, Commanding General, 4th ID, believes that this capability has been key to the evolving Force XXI strategy for success.[35] At this stage, while technology is being developed and systems refined, MG Coffey wants to be able to dial in the information he needs, filter it to his specifications, and display the product. Due to screen clutter and resolution, he uses three screens to display the information he needs--a mechanism which he finds sufficient for now. III Corps is using six screens. Even though this is far from the desired end state, it is providing commanders with information displays that allow them better to synchronize their operations and make decisions. Flat panel displays are on the horizon. There are a number of commercial vendors working, in conjunction with the Advanced Research Project Agency, on development of ruggedized, flat panel displays which provide resolution required for decision-making. This is an area which holds great promise, but which is not yet ready for the field environment.

UAV video is also being piped into the commander, although still on a separate monitor. Commanders find it very useful for helping establish situational awareness. However, enhancements must occur to increase its utility. Specifically, the UAV gives only a soda straw look at the battlefield. A visualization tool allowing the viewer to see where the UAV is imaging and the use of grid coordinates would place the picture in context. JSTARS feeds are also very useful, because they complement the rest of the intelligence picture and allow the commander to visualize the battlefield flow.

The key to situational awareness and visualization is graphic representation. That is why the ability to use multimedia tools is so important. Graphics, with icons and back-up retrievable

text permit the commander to cue information he needs, integrate it, and visually synchronize his battlespace.[36]

<center>Other Factors Bearing on Situational Awareness</center>

Uncertainty will not be eliminated with digitization. Commanders must understand uncertainty and factor it into their decision making process. Uncertainty occurs in all phases of collection, processing and dissemination. Intelligence data will always be incomplete due to the difficulty in collecting and identifying all relevant data. Sources can sometimes send conflicting data and data may easily support more than one conclusion. Data collection is bounded by advances in technology and by human dynamics (characteristics, idiosyncracies, differences, abilities, limitations). The language used to convey information can be imprecise or ambiguous. And finally, when secondary analysis occurs, vice analysis of raw data, interpretation and inference can distort the initial reading.[37] While none of this is reflected in displays or text, uncertainty plays a critical role in situational awareness. As decision support tools mature, they should help reduce this uncertainty.

The human dimension is also an important, but less obvious, aspect of making the commander situationally aware. Again, it begins with understanding the commander's needs so that the intelligence product is responsive. Analysts must be in the commander's head while simultaneously remaining objective. The analytical process and product must take into account the commander's perception of the battlefield. Information that violates the perception should trigger an alarm to action on the part of the commander (need for additional information, a required action or decision). Analysts also must be aware that commanders may have preconceived notions about the way the operation will unfold, and use information to support

<center>23</center>

their conclusion, whether it is right or wrong. A final human dynamic is the ability of the commander to understand what is being presented--another reason that the graphic presentation software must be flexible and tailorable.

Technology and the rapid pace of the battlefield have created a shortened decision cycle. With commanders under the gun to make quick decisions, it is imperative all effort be made to develop a seamless, flexible, responsive C4I architecture and system. Process will be every bit as important as systems. Organizational, cultural, structural, and psychological dynamics, taken as a whole, should help eliminate barriers to information flow from sensor to user.

For the foreseeable future, digitized units must be prepared to operate in partially or non-digitized environments. National Guard and Reserve forces are only beginning the road to digitization, yet they will be a part of every operation. Fighting "joint" is also a way of life, yet many of the key systems lack interoperability across services. Critical systems like the Air Force's Contingency Theater Automated Planning System (CTAPS) and Combat Intelligence System support Army functions like mission support, air tasking orders, and analytical exchanges. Similar disparate systems exist in the Navy, the Marine Corps, and the Special Operations Command. Common pictures, knowledge-based information presentations, and distributive collaboration should become routine functions in a joint architecture.

Situational awareness and a common picture of the battlefield are even more difficult in multinational operations. Systems like the Limited Ops/Intel Centers Europe (LOCE) offer a common picture and are being used with great success in Bosnia, but for the most part, we will have to rely on liaison teams, equipped with U.S. communications and automation, to support operations. Regrettably, we have taken a step backwards in the quest for multinational

interoperability with the Congressional fund cutoff for a common digitization effort with Germany and Great Britain.

Without a viable, realistic information warfare plan, there will be no situational awareness. The defensive aspect of information warfare (C2 Protect) includes "all actions necessary to ensure the availability, confidentiality, and integrity of reliable information vital to national security needs."[38] A U.S. Defense Science Board Summer Task Force, concluding that the U.S. is highly vulnerable to electronic attack, suggested that conducting an information warfare campaign is as critical to military operations as was the introduction of stealth technology.[39] The statistics are startling. "Military computers are probed by outsiders close to 500 times a day, Pentagon experts believe. But only about 25 of those are detected, and only two or three are reported to security officials. Once the first computer is cracked, nearly 90 percent of the other computers recognize the intruder as a legitimate user."[40] The intelligence community, led by the DCSINT and the Intelligence and Security Command, is establishing a Red Team to address Force XXI vulnerabilities. Understanding and taking actions to limit our vulnerabilities and to create "protect" tools are critical to Force XXI success on the battlefield. If we are serious about security, the entire TF XXI network must get a good shake-out prior to the NTC Advanced Warfighting Experiment in February 1997.

Finally, the key to Force XXI success boils down to trained and ready soldiers. A sound training program in TRADOC schools, focused on the basics and selected information skills (hands-on with fielded systems), must be coupled with subsequent on-the-job training. Given the current pace at most installations, distributed training can help provide the required building blocks for soldiers and elements to function as part of collective operations in garrison, field

exercises, and contingencies. Across all grade levels, leaders' training will be more important than ever due to more synchronization, a networked structure, a non-linear battlefield, and a shortened decision cycle. The very same multi-media technology that is used by Force XXI units in operations can also be used as the backbone for exportable training. The Intelligence School's Classroom XXI concept and the Armor School's Staff Training Modules capture the benefits of small unit instruction via an Internet-like program. Digitization has allowed us to do more operationally, but it also requires soldiers to do increasingly complex, multiple tasks. Automation should be the means to the end--not the end, and training must reflect this precept.

We will never achieve 100 percent situational awareness. To say this number out loud, or advertise it is to do commanders, intelligence officers, and all units across the battlefield a tremendous disservice. What we can say is that we are seeing overwhelming evidence that the degree of uncertainty is being significantly reduced, that what we know about the battlefield, its geometry, and the disposition, capability and intentions of friendly and enemy units is exponentially greater than it has ever been before, and that it will continue to improve. Senior leaders such as LTG Menoher and MG Coffey believe that we may even exceed 90 percent, given the right battlefield circumstances (eg. environment similar to Desert Storm). Under other circumstances, situational awareness will decline considerably. There will always be fog and friction. The enemy will generally refuse to cooperate with our plan and will try to deceive us. Weather, terrain, and the effect of terrain masking will affect our ability to collect, communicate and operate. Soldiers will only perform as well as they are trained, led, and motivated. Things will break--usually at an inopportune moment. And finally, in spite of passing timely, accurate,

responsive information to the commander, it may not be presented in accordance with his needs or perception, or he may elect not to use it, or he may just make the wrong decision.

<u>Recommendations for Achieving Force XXI Goals</u>

1. <u>Collection</u>. Develop and integrate all sensors to provide a seamless collection web. Focus on the family of systems as the highest priority, but also incorporate new technology (like acoustic sensor arrays, voice identification, on-board processing) where possible. Identify and develop all potential sources of information (intelligence and non-intelligence systems) so that there is one single sensor architecture--begin in the acquisition cycle. Develop and integrate collection, requirements and intelligence synchronization management tools to create one multi-echelon capability.

2. <u>Processing</u>. Continue data processing and analysis initiatives. Add analyst tools and incorporate CI/HUMINT applications into the digitization architecture. Incorporate Pathfinder-like capabilities to permit analysts to comb through and organize large amounts of free text information. Refine document translator software and port over into operations. Continue to add processing speed and parallel processing applications. Better integrate imagery and ATR technology into processing and analysis. Develop a fusion architecture that addresses intelligence and non-intelligence contributors to the common picture--build the systems architecture around the requirement and create one big, interactive data base.

3. <u>Communications</u>. Work with industry to field secure, fast, and reliable means of communications. Incorporate promising technology like ATM, SONET, spread spectrum, and satellite and broadcast innovations, et. al. Build seamless communications paths that are

sufficiently robust down to the tactical level. Network management systems must be part of the architecture to enable identification of problems and workarounds.

4. <u>Dissemination</u>. Develop a "push-pull" architecture and field systems that get required information quickly to the user. Incorporate GBS/ DBS technology to enable dissemination in tactical communications environments. Use compatible data links to central processing systems to avoid complexity. Technology that can help prioritize, filter, alarm, and aid commanders in decision making should be a priority. Systems which interface with users should be set up like the Internet and Intelink, with an ability to work from a home page, pull what is desired, and display information in the form of a graphic representation with accompanying text and hyperlinks. Continue to improve the technical aspect of dynamic updates, with quick and easy being the watch words.

5. <u>Display</u>. Develop and field display capabilities which are dynamic, versatile, flexible, and able to be used in a mobile environment. Flat panel display initiatives should continue. Commanders should be able to display multiple windows on one screen, each capable of being used separately or combined to enhance visualization and decision-making. This should help the commander tailor and declutter information, and, as importantly, plan, rehearse and execute the operation from the same display. Fine tune and continue to develop multi-media presentations and collaborative planning. Standardize VTC systems. Add decision tools and an ability to display ambiguity and probability.

5. <u>Service/joint/multinational interoperability</u>. Implement the top-down approach to systems interoperability. Automate as we fight. Continue to support multinational interoperability initiatives, but not at the expense of getting our own system linked.

6. C2 Protect. The Army leadership must take ownership of security issues. The Red Team must be funded and permitted to assess vulnerabilities. Their recommendations should be implemented to ensure that soldiers, systems, and the nation are not compromised.

7. Training. Put training is on the front burner. Training should be seamless, from school house to the unit. Training XXI must be a tandem piece to Force XXI. Use Force XXI technology to build distributed training packages. Commanders and subordinates also must be trained on how to develop and respond to information needs, CCIR, and decision making. Leader development will be more important than ever and must be emphasized in schools and in large scale unit training. A solid training foundation can permit us to use technology wisely.

Conclusion

Force XXI is the way forward. With it, the Army can better dominate battlespace, control battlefield tempo, achieve overwhelming lethality and execute a quicker, more decisive victory while minimizing casualties. The Army is well on its way to becoming a digitized and more situationally aware force. Still, Force XXI plans for collection, processing, dissemination and display processes are not sufficient to achieve total situational awareness. Even if we apply all available technological tools, fog, friction, and human nature will intervene. Commanders will always make decisions and decisions will be based on the information available. The Army's task is to continuously endeavor to limit the amount of uncertainty and aid the commander in decision making. We must continue to focus on gathering and presenting a picture of the battlefield that enables the commander to make decisions faster and permits units to act more quickly than the adversary. The decisive advantage that is caused by an exponentially greater situational awareness of friendly and enemy forces will help save lives and win wars. C4I is a

force multiplier. In the end, however, we need trained, astute leaders and soldiers who leverage the science of war to succeed at the art of war. It is this combination of technology and operational and strategic art in joint and multinational operations that will truly be the measure of how well we succeed in the 21st Century.

APPENDIX

ACRONYMS

ACE	Analysis Control Element
ASAS	All Source Analysis System
ATM	Asynchronous Transfer Mode
ATR	Automated or Automatic Target Recognition
BCTP	Battle Command Training Program
BDA	Battle Damage Assessment
BFA	Battlefield Functional Area
CCIR	Commanders Critical Information Requirements
CGS	Common Ground Station
CI	Counterintelligence
C4I	Command, Control, Communications, Computers, and Intelligence
DCSINT	Deputy Chief of Staff for Intelligence
DBS	Direct Broadcast System
DISE	Deployable Intelligence Support Element
GBS	Global Broadcasting System
HUMINT	Human Intelligence
IMINT	Imagery Intelligence
INTELINK	Intelligence Link
JCMT	Joint Collection Management Tools
JDISS	Joint Deployable Intelligence Support System
JIC	Joint Intelligence Center
JRTC	Joint Readiness Training Center
JSTARS	Joint Surveillance Target Attack Radar System
JWICS	Joint Worldwide Intelligence Communications System
MCS	Maneuver Control System
MI	Military Intelligence
MITT	Mobile Integrated Tactical Terminal
MSI	Multi-Spectral Imagery
NTC	National Training Center
OSINT	Open Source Intelligence
PIR	Priority Intelligence Requirements
RL	Receive Location
RWS	Reconfigurable Work Station

SIGINT	Signals Intelligence
SIV	Systems Integrating Vehicle
TENCAP	Tactical Exploitation of National Capabilities
TF	Task Force
TRADOC	Training and Doctrine Command
TRRIP	Theater Rapid Response Intelligence Package
UAV	Unmanned Aerial Vehicle
VTC	Video Teleconferencing

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